



# Audited Stress Rating Program

## Standard Operating Procedure

### INTRODUCTION

These procedures allow a lumber manufacturer to establish higher Fb and E values for its finished product as compared to the NDS Supplement. Published Fb values derived from ASTM D1990 are based on a 75% confidence interval as a result of dividing the lower 5<sup>th</sup> percentile of the bending strength by a combined safety & load duration factor of 2.1. Using a larger factor of 2.5 applied to the bending capacity in an effort to account for variability in bending capacities within a visual grade (e.g., a #2 piece with a maximum knot as compared to a #2 piece with a knot that is slightly too big for a #1) along with increased qualification & daily QC sampling requirements as compared with typical Machine Stress Rated QC procedures, it is possible for a mill to audit their visually graded production as described in these procedures and be able to label it accordingly if these procedures prove it to be superior.

### Section 1 – General Requirements for Audited Stress Rating Program (ASR)

#### 1.1 Program Requirements

- This Standard Operating Procedure (SOP) applies to TP subscribers that are qualified to visually grade dimension lumber.
- This SOP applies only to the products for those species listed in a standard grade rule recognized by the American Lumber Standard Committee (ALSC).
- Visual grade requirements are species-specific and are found in the ALSC-recognized standard grade rule that pertains to a species or species grouping.
- Published design values and properties for visually graded lumber are species-specific and are found in the ALSC-recognized standard grade rule that pertains to a species or species grouping.
- The object of the ASR program is to allow for mill-specific combinations of Fb and E values as needed by their customers. Only one ASR grade per visual grade shall be produced during any given production run.
- All other requirements, such as moisture content, manufacture classification, size, etc, shall remain in effect as limited in the ALSC-recognized standard grade rule that pertains to a species or species grouping.

#### 1.2 Subscriber Requirements

- Mill shall be an active TP subscriber.
- Mill shall create, maintain and follow TP-approved QC procedures.
- Subscriber shall operate and maintain proper test equipment and specifically shall maintain accuracy of test equipment as specified in Section 4.



- Subscriber shall designate at least one employee as the ASR agent. This agent shall demonstrate their proficiency in understanding and application of this SOP to a qualified TP representative. Specifically, proficiency in sample selection, sample testing, and test result analysis are key areas of importance.
- Each production shift shall be monitored by an ASR agent. This pertains to QC sample selection and testing.
- Subscriber shall perform and maintain accurate records of all required test and calibration results. Subscriber shall archive these records for a minimum of two years and shall make these records available for TP or ALSC review.
- Subscriber shall maintain an identification system on the outside of the units sufficient enough to be able to trace the production runs back to specific QC findings.

## Section 2 - Qualification Procedures for ASR

- Grade qualification shall become void after a period of twelve (12) months has elapsed with no production of that ASR grade.
- Prior to pulling qualification samples, it is recommended (although not required) that a mill perform some preliminary testing in order to make an educated decision as to what ASR grade(s) shall be attempted for qualification. Market demand shall likely dictate which grade combinations mills shall explore. Broad sampling tests for MOR would help a mill establish which visually graded items yield favorable results if they choose to do so.
- An ASR grade shall be any combination of Fb and E values for which the mill qualifies, but for the sake of market recognition and acceptance, it is recommended to choose from the MSR grades that currently exist.
- Some examples of possible ASR grades include, but are not limited to:
  - #1, 1650f-1.5E
  - #2, 1450f-1.3E
- Only one (1) ASR grade shall be used for any related visual grade during any given production run.
  - An example of a permissible production run grade combination is:
    - #1, 1650f-1.5E
    - #2, 1450f-1.3E
  - Another example of a permissible production run grade combination is:
    - #1
    - #2, 1450f-1.3E
  - Another example of a permissible production run grade combination is:
    - #2DNS, 1650f-1.5E
    - #3



- An example of an impermissible production run grade combination is:
  - #1, 1650f-1.5E
  - #1, 1450f-1.3E
- Another example of an impermissible production run grade combination is:
  - #1
  - #1, 1650f-1.5E
- Another example of an impermissible production run grade combination is:
  - #2DNS, 1650f-1.5E
  - #2
- A list of all qualified ASR grades and ASR grade combinations shall be kept by the mill for review during routine (approximately monthly) visits by TP. Any changes in ASR grade qualification shall be documented by an ASR agent with TP supervision.

## 2.1 Sample Selection

- Sample selection shall be overseen by a TP representative.
- A qualification “cell” consists of 125 pieces selected for testing from each size/grade/species combination for which the mill wishes to qualify.
- Each cell shall be pulled from one visual grade. More restrictive, proprietary grade requirements are allowable and shall become a permanent part of the final ASR grade description, but the base visual grade description shall always be maintained.
- Each cell shall be qualified with no above grade and no below grade included with regard to the mill’s actual grade categories. If a mill makes changes to the grades that it pulls after qualification in a manner that affects the original population tested, requalification shall be required.
- See examples:
  - Example 1 – The mill pulls the following visual grades: #1, #2, & #3 and wants to qualify its #1 and #2 visual grades. The #1 sample shall consist of #1 and better pieces while the #2 sample shall consist of #2 only (no above or below grade).
  - Example 2 – The mill pulls the following visual grades: #1, #2, & #3 but only wants to qualify its #2 visual grade. The #2 sample shall still consist of #2 only (no above or below grade).
  - Example 3 – The mill pulls the following visual grade: #2. The #2 sample shall consist of #2 and better pieces.
  - Example 4 – The mill in example 3 above decides to start pulling #1 and #2. The mill shall have to requalify its #2, because the higher visual grade being removed would affect the original averages.



- Qualification samples shall be selected from units of visually graded lumber. The intent is to strive for as much of a broad mix of run dates as possible. Qualification samples shall be selected consecutively (only excluding those pieces that do not meet the above or below grade criteria). No more than 30 pieces shall be pulled from any single unit, though.
- All qualification specimens shall be verified by a TP representative to meet the appropriate visual grade requirements.
- Additional qualification pieces shall be selected in case replacements are needed due to over sized knots, EMC, etc.

## 2.2 Qualification Sample Testing

- Qualification testing shall be overseen by a TP representative.
- Pieces may be tested for the required E measurement as well as MOR.
- Discard any piece with a defect exceeding the appropriate visual grade. Test the minimum sample size needed of on-grade pieces without bias.
- Moisture content shall be measured and recorded at the time of the test. Discard any piece exceeding the moisture content limit.

### 2.2.1 Average Edgewise E:

- Random placement- the grade stamp shall face the tester and shall be consistently placed to either the tester's right or left.
- Third point loading
- Span ratio of 21:1 (where possible)
- Piece-centered lengthwise orientation
- Maximum 16,000 psi / minute loading rate
- Record MOE for each individual piece
- Calculate the Average MOE for the qualification sample

### 2.2.2 Bending Strength (MOR):

- Random placement (same as MOE above)
- Third point loading
- Span ratio of 21:1 (where possible)
- Maximum edge defect- located between, or as close to, the loading points as possible.
- Loading rate that complies with ASTM standard D4761 resulting in a time to failure of approximately 1 minute.
- Record actual MOR values.



### 2.3 Qualification Test Results Analysis

- Each cell's qualification results shall be evaluated independently.
- The results of the E and bending strength tests shall determine the maximum possible cell qualification levels.

#### 2.3.1 Average MOE

- The Average E value shall be determined from the qualification samples.
- The ASR E value shall not exceed the Average E value; the mill may choose to label a lower ASR E value than the average established during qualification.

#### 2.3.2 Minimum E:

- The Minimum E is the estimate of the lower 5<sup>th</sup> percentile of the MOE.
- The mill shall use an ASR E that does not exceed the following factor:
  - Minimum E / 0.82

#### 2.3.3 MOR

- The lowest MOR value shall be used to calculate the maximum possible qualified ASR Fb value using the following formula:

$$\text{ASR Fb} = \frac{\text{MOR} * \text{L}}{2.5 * \text{b} * \text{d}^2}$$

- ASR Fb = ASR bending qualification value (psi)
  - MOR = Modulus of Rupture (lb)
  - b = base (actual in.)
  - d = depth (actual in.)
  - L = Test Span Length (actual in.)
  - 2.5 = Safety Factor
- The mill may choose to label a lower ASR Fb value than the maximum established during qualification.

## Section 3 – Quality Control Requirements

### 3.1 QC Sampling

- Each ASR cell produced shall be monitored as described below.
- QC sampling shall be performed at a rate of one (1) piece tested per 1,000 pieces produced for each production run with a minimum sample size of 30 pieces per production run tested.
- The minimum sample size is based on ASTM standard D2915 with the following assumptions:
  - Coefficient of Variation = 20%
  - Average MOR = 8,000
  - Lower 5<sup>th</sup> percentile = 5,000



### 3.1.1 Intensive Sampling

- Immediately following qualification, intensive QC sampling shall be performed on the ASR grade or ASR grade combinations qualified. From each of the first five production runs following the qualification, sampling frequency shall be as specified below:
  1. A minimum of 60 pieces per production run shall be tested.
  2. Sample at a rate of one (1) piece per 500 pieces produced.
  3. Count five (5) pieces of the grade being tested.
  4. Select the next consecutive number of pieces necessary to achieve proper sampling frequency of the grade tested as produced under production line conditions. A minimum of 8 pieces per hour shall be necessary for a routine 8-hour production run to ensure the minimum intensive sample is pulled.
  5. No more than 60 minutes of production time shall pass without pulling a QC sample.

### 3.1.2 Routine Sampling

- Following the required intensive sampling period, routine QC sampling shall be performed on the ASR grade or ASR grade combinations being produced as specified below:
  1. A minimum of 30 pieces per cell per production run shall be tested.
  2. Sample at a rate of one (1) piece per 1,000 pieces produced.
  3. Count five (5) pieces of the grade being tested.
  4. Select the next consecutive number of pieces necessary to achieve proper sampling frequency of the grade tested as produced under production line conditions. For example, a minimum of 4 pieces per hour shall be necessary for a routine 8-hour production run to ensure the minimum sample is pulled.
  5. No more than 60 minutes of production time shall pass without pulling a QC sample.
  - 6.

### 3.2 QC Sample Testing

- Average Edgewise E shall be tested as a part of daily QC.
- Minimum Edgewise E shall be calculated as a part of daily QC.
- MOR shall be tested as a part of daily QC.
- Offline strength testing to verify audited Fb shall be conducted by proof testing using appropriate proof loading equipment capable of imposing a stress on the test specimen of at least 2.5 times the assigned property value. The additional 0.4 over 2.1 represents an increase of approximately 30% over the 1.3 safety factor portion of the combined safety & load duration factor of 2.1. This is an effort to account for the increased variability of bending strengths within a single visual grade.



- Tested pieces that are damaged during the QC process shall have the gradestamp obliterated and shall not be included with any gradestamped material.

### 3.3 QC Test Result Analysis

- Use the following formula to calculate QC proof load

$$P = \frac{\text{ASR Fb} * b * d^2}{L} * 2.5$$

- P = Proof Load (lb)
- ASR Fb = ASR bending design value
- b = base (actual in.)
- d = depth (actual in.)
- L = Test Span Length
- 2.5 = Safety Factor

#### 3.3.1 In-Control

- Using the formula in section 3.3 above, all QC test results shall meet or exceed the required proof loads in order to be considered In-Control.
- All MOE QC results shall meet or exceed the labeled ASR E value in order to be considered In-Control.
- All minimum E values shall meet or exceed the ASR E x 0.82.
- If these test results show the process for the properties required for the mechanically graded product being produced to be in-control, all lumber represented by the sample is satisfactory for shipment.

#### 3.3.2 Out-Of-Control

- If any QC sample does not meet or exceed the ASR grade requirements described in Section 3.3.1, the lot is considered to be Out-Of-Control.
- Upon determining the production is out-of-control, all lumber represented by the sample shall be held pending results of confirmation tests as set forth below:
  - The visual grade and moisture content shall be checked.
  - The static test equipment shall be checked for accurate calibration.
- RESOLUTION 1: If a portion of the sample is found to be below grade for any reason, that portion of the sample shall be discarded and replaced with material from the same production time frame.
- RESOLUTION 2: If the test equipment is found to be out of calibration, the original sample shall be retested.



### 3.3.3 Summary of Out-Of-Control

- If the QC sample is still Out-Of-Control after resolutions 1 & 2 have been attempted, all material that has been produced since the last positive QC findings were obtained shall be obliterated and relabeled with the next lower ASR or visual grade with which the sample complies.
- QC findings that result in Out-Of-Control three (3) times in any five (5) consecutive production runs (approximately 40 consecutive production hours) shall require the mill to requalify that cell (grade/width/species combination) as described in Section 2.

### 3.4 Record Keeping

Subscriber shall maintain QC records for at least two (2) years for the following:

- Test equipment calibration checks;
- Quality control tests;
- Production stoppages occasioned by the quality control provisions with a detailed explanation or the corrective action(s) taken.
- Qualified ASR grades and changes in ASR grade levels.

## Section 4 – Equipment, Setup, and Calibration

### 4.1 Offline Test Equipment

- At least annually, the accuracy of the subscriber's static test equipment shall be verified against TP's calibrated equipment or certified by a TP-approved independent testing agency to verify the integrity of the deflection and load measuring equipment.
- A proof ring is used to calibrate load cells in certain test equipment. Proof rings shall be certified annually by a qualified testing laboratory with standards traceable to the National Institute of Standards & Technology (NIST) in accordance with the ASTM E-74 standard.
- Bending Proof Loaders
  - The bending test span shall be set to an accuracy of +/- 1/8" of the required span.
  - The static bending test equipment shall be capable of measuring displacement to 0.001". The deflection of the wood is measured relative to the reaction supports.
  - Where the unsupported overhang creates a flexural stress in the member, the calculation of MOR shall consider the effect due to the weight of the overhangs if to do otherwise results in nonconservative results.
  - Proof Loader shall be verified daily (before testing begins) using an aluminum bar with the test bench set for 2x4 or 2x6 measurements. Readings shall be within 1% of the target value.
  - Load cells in a bending proof loader shall be verified with a proof ring once per week, unless no production was run that week. Readings shall be within 1% of the target value.



#### Section 5 – Residual Production

- ASR Residual lumber is lumber which meets the required visual grade, but does not meet the minimum QC requirements for the ASR grade being labeled.
- Residual lumber shall be placed in the next lower visual grade for which it qualifies, provided that the QC results meet or exceed the published Fb of that next lower visual grade.
- A mill may choose to lower its ASR grade and label it as such based on changes in raw material in order to minimize residual production. Documentation of such must be kept in the mill's QC records.
- Residual lumber products shall be grade stamped at the production site in accordance with existing ALS provisions or, if shipped not grade stamped, marked in a fashion to indicate the lumber has been passed through the ASR process and was rejected.

#### Section 6 – TP QC Overview

- TP shall conduct a minimum of twelve (12) approximately monthly verifications of subscriber's conformance to TP's ASR SOP, with specific regards to subscriber's documentation of:
  - Accurate and complete daily QC control test results;
  - Weekly static test equipment calibration checks;
  - Production stoppages resulting from out-of-control findings;
  - Visual grade and other labeling requirements.
- TP shall require subscriber to obliterate the grade stamp on any material found to be nonconforming to the requirements as labeled. This includes proper documentation of positive QC findings.
- TP shall conduct annual physical tests of at least one ASR grade/size/species to check appropriate lumber output criteria.
- TP shall develop deflection/MOE conversion charts and establish required proof load levels for the particular proof testing equipment being used.

#### Section 7 – Labeling

- Routine labeling includes Agency Logo, Mill ID, Visual Grade, Moisture Content, Species/Species Group
- ASR graded material shall also include "AUDITED RATING" or "ASR"
- ASR graded material shall also include the Fb and E values. Examples include:
  - No. 1 1650f-1.5E ASR
  - No. 2 1450f-1.3E AUDITED RATING